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The Effect of Urinary Triclosan on SerumThyroxine in US Population:
2011-2012 NHANES Data

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Abstract

Background: Triclosan is an antibacterial agent that is added to personal care products to prevent bacterial growth. The FDA banned the use of triclosan in soap in 2016 due to safety concerns. Triclosan is considered an endocrine disruptor and had reported effects on the body, including changes in thyroid function.

Purpose: The purpose of this study was to assess the relationship between urinary triclosan and serum thyroxine in U.S adults.

Methods: Data from the 2013-2014 National Health and Nutrition Examination Survey (NHANES) were analyzed ($N = 1,476$). Linear regression analyses were performed to assess the relationship between log transformed triclosan and BMI, adjusting for age, race/ethnicity, gender, annual household income, and smoking status.

Results: Median urinary triclosan level was 5.9 ng/ml and the average serum thyroxine level was 8.10 ng/dl. After adjusting for covariates, triclosan exposure did not have a significant association with serum thyroxine ($B = -0.005$, 95% CI = $-0.047, 0.037$, $p = .820$). The results were similar when stratified by gender. Across gender, females had a higher exposure of triclosan than males with an average level of 2.08 ng/ml compared to 1.81 ng/ml. Females also had higher thyroxine (8.29 ng/dl) levels.

Conclusion: Endocrine disruptors are a public health issue and can impact the burden of chronic disease. Although this study did not show a significant between triclosan and thyroxine, it did identify factors associated with thyroxine levels. Additional research needs to be done to further assess the relationship between triclosan and thyroxine.

Keywords: Endocrine disruptors, gender, linear regression, antibacterial agent, thyroid function

The Effect of Urinary Triclosan on Serum Thyroxine in US Population: 2011-2012 NHANES Data

According to the Food and Drug Administration (FDA), triclosan is an antibacterial agent that is added to consumer products to prevent bacterial growth (U.S. Food & Drug Administration [FDA], 2017). Triclosan is used in antibacterial soaps and cleansers, cosmetics, and toothpaste. Triclosan is also added to children's toys and some types of plastic (FDA, 2017). In 2016, the U.S. Food & Drug Administration (FDA) banned triclosan from soaps, body washes, and other FDA regulated products due to safety concerns (Kodjak, 2016). There is some concern that triclosan exposure may act as an endocrine disruptor and disturb the thyroid hormone axis. More specifically, triclosan has been linked with lower serum triiodothyronine (T3), thyroxine (T4), and thyroid stimulating hormone (TSH) (Cullinan, Palmer, Carle, West, & Seymour, 2012). The thyroid is one of the master glands in the human body and thyroid hormones play a vital role in human brain development, body growth, and maintaining metabolism (Sargis, 2017).

Triclosan belongs to a family of chemicals known as phenols. Several lines of evidence suggest an endocrine disrupting effect of Triclosan on the thyroid. A recent epidemiology study explored the link between phenols and parabens (a related class of endocrine disruptor) on reproductive and thyroid hormones in pregnant women. The reproductive hormones, estradiol, progesterone, and sex-binding globulin (SHBG) were measured along with the thyroid hormones, T3, T4, and TSH (Aker et al., 2016). It was hypothesized that phenols and parabens will have an effect on hormone levels and endocrine functioning. The results showed that as the levels of the parabens increased, there was a decrease in T3 and an increase in T4 (Aker et al.,

2016). It was reported that TSH had no significant relationship with any of the exposures.

Triclosan was not significantly related to any of the hormone levels measured (Aker et al., 2016).

Purpose Statement

The purpose of this study was to assess the association between urinary triclosan and serum thyroxine while adjusting for demographic factors (age, gender, race/ethnicity, and income) and BMI in the adult population.

Literature Review

Triclosan

Methods of triclosan absorption. The main routes of absorption for triclosan are dermal and oral. Dermal absorption is through the use of body lotions, soaps, and other personal care products, while oral exposure is through the use of triclosan containing toothpaste and mouthwash (Lu et al., 2017). A study was conducted on a sample of physicians and nurses from two separate hospitals to understand the effects of dermal absorption of triclosan. The first hospital in the study used soaps that contained 0.3% triclosan, while the second hospital did not (MacIsaac et al., 2014). The use of triclosan-containing toothpaste (TCT) was adjusted for as a possible covariate. It was found that the physicians at hospital 1 had higher levels of urinary triclosan than physicians at hospital 2, when adjusting for TCT (MacIsaac et al., 2014).

An additional study done in China observed different consumer products containing triclosan and which led to the most absorption. The study used samples of 150 different personal care products such as, toothpaste, face cleanser, shampoo, body wash, etc. (Lu et al., 2017). Levels of triclosan were measured in 47% of the samples (Lu et al., 2017). Although hand sanitizers and toothpaste had the highest concentration of triclosan, body lotion was found to

have one of the highest rates of dermal absorption. It was hypothesized that the high rate of triclosan intake was due to the large absorption area (Lu et al., 2017).

Oral exposure is another route of triclosan absorption. One study looked at the amount of triclosan absorbed in the mouth following the use of mouthwash containing 0.03% triclosan. The results showed that 4-13% of the triclosan was retained (Lin, 2000). That amount was lower than previously reported measurements. With using the mouthwash twice a day, 0.660mg of triclosan was retained per day (Lin, 2000). About 2-4% of the daily triclosan dose was absorbed into the blood (Lin, 2000). Plasma triclosan was measured 8 days after the conclusion of the study and it was found that there was no long-term retention of triclosan. The amount of triclosan returned to the baseline levels recorded at the start of the study (Lin, 2000).

Metabolism of triclosan and thyroxine. Triclosan metabolism occurs in the liver. The liver metabolism typically occurs before biliary elimination and the unconjugated triclosan is eliminated in the feces (Moss, Howes, & Williams, 2000). A recent study looked at the dermal metabolism of triclosan using rats and human skin. A radiolabeled triclosan solution was applied to the skin and a receptor fluid was used to measure the concentration of the triclosan byproducts (Moss et al., 2000). Of the dose of triclosan that was applied to the rats, 23% appeared in the receptor fluid. Of the absorbed triclosan, 17% was triclosan while 4.1% was the glucuronide metabolite and 0.9% was triclosan sulfate. In the human skin sample, it was found that the concentration of glucuronide concentration increased between two and 24 hours (Moss et al., 2000). After 24 hours, the receptor fluid showed a 12% triclosan concentration, 3% triclosan sulfate concentration, and a 3% glucuronide concentration.

An additional study replicated those findings. The study also showed that while in the liver, triclosan gets broken down into glucuronide and sulfate conjugates.

A 7 μ L, 64.5mM concentration of radiolabeled triclosan was applied to the skin and glucuronide and sulfate conjugates were present 24 hours after application (Fang et al., 2010).

A study of rat dams looks at how triclosan decreases thyroxine via the upregulation of hepatic metabolism. Pregnant rats were orally administered triclosan and thyroid hormones and liver enzymes were measured (Paul et al., 2012). The results showed that the main effect of triclosan was on thyroxine levels. There was a statistically significant decrease in thyroxine levels in the rat dams. Serum thyroxine decreased by 23% and 28% in fetuses (Paul et al., 2012). There was also an observed increase in liver enzyme activity which was associated with the decrease in thyroxine levels (Paul et al., 2012). There was an increase in biomarkers for hepatic catabolism as well. The increase in liver activity is associated with the reduction in thyroxine (Paul et al., 2012).

Triclosan excretion. NHANES data from 2003-2006 was used to understand triclosan excretion. Previous research has shown that the majority of triclosan can be excreted through the kidneys. NHANES participants over the age of 20 with normal, mildly decreased, and (undiagnosed) chronic kidney disease were selected (Li et al., 2011). Glomerular filtration rate was used to determine kidney function. Although not statistically significant, the average excretion of triclosan decreased as kidney function decreased (Li et al., 2011). This result was consistent for both sexes. There was an observed statistically significant decrease in excretion in participants under the age of 65 with reduced kidney function (Li et al., 2011).

Thyroxine (T4)

The role of thyroxine in the body. Thyroxine is one of three hormones secreted by the thyroid. Thyroid function is regulated by a negative feedback loop that is controlled by the hypothalamus (Brady, 2017) (see Figure 1). The hypothalamus releases thyrotropin-releasing

hormone (TRH) which stimulates the anterior pituitary to release thyroid-stimulating hormone (TSH). TSH in turn stimulates the thyroid gland to release thyroxine (Brady, 2017). Thyroxine plays a role in the body's metabolism. It aids in the regulation of heartrate, body weight, breathing and body temperature. Excess thyroxine causes rapid heartrate, weight loss, heat intolerance, anxiety, tremors and alter hair growth/shedding cycles. Low concentrations of thyroxine can lead to fatigue, depression, and muscle and joint pain (Brady, 2017).

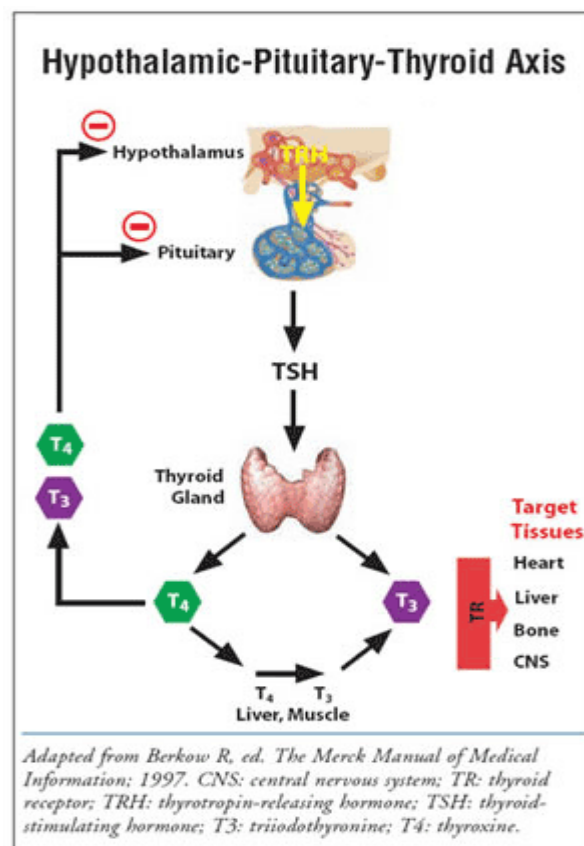


Figure 1: Thyroid hormone release. Copied and pasted from Bolick Chiropractic & Integrated Wellness website (<https://bolickclinic.com/hypothalamic-pituitary-thyroid-axis/>).

Role of thyroxine in neurodevelopment. Thyroxine is a hormone that is essential for neurodevelopment in fetuses. Up until around the 12th week of gestation, fetuses rely on the

mother's thyroid hormones. Reduced thyroid hormone levels in pregnant women is known to cause neurological defects in infants (Julvez et al., 2013). A study of pregnant women was used to understand thyroxine's effects on cognitive development. The thyroid hormone levels of the women were measured at eight and 20 weeks gestation and cognitive development of their children was measured at 14 months (Julvez et al., 2013). The results showed that women who had low levels of thyroxine during pregnancy had a higher likelihood of their children having cognitive delays. It was also shown that women who took thyroid medication during pregnancy had children with a lesser risk for cognitive delays (Julvez et al., 2013). That finding was replicated in a study in Japan. Women diagnosed with hypothyroidism in early pregnancy gave birth to children without neurological complications when they received appropriate thyroxine supplementation beginning in the first trimester (Momotani, Iwama, & Momotani, 2012).

Research has shown that triclosan can affect the body's concentration of thyroxine. As study regarding triclosan exposure and maternal and fetal thyroid hormone levels showed that triclosan had an inverse relationship with maternal thyroxine levels (Wang et al., 2017). With each 10-fold increase in maternal triclosan concentration, there was a 2% decrease in thyroxine. There was association between maternal triclosan concentration and fetal thyroxine levels. An inverse relationship was identified between triclosan and fetal triiodothyronine (T3) levels (Wang et al., 2017).

Triclosan and BMI. As an endocrine disruptor, triclosan has been shown to decrease thyroxine levels which can affect the body's metabolism and cause weight changes. A study by the Environmental Protection Agency (EPA) suggests that triclosan alters thyroid hormones through the activation of the human pregnane X receptor and the inhibition of diiodothyronine sulfotransferases (Paul, Hedge, Devito, & Crofton, 2007).

The current research on triclosan's effect on BMI has shown mixed results. Triclosan has been shown to have both a positive and negative association with BMI. One study used NHANES data from 2003-2008 to understand the relationship. The study looked at BMI in adults while adjusting for survey year, sex, age, race, socioeconomic status, and cotinine levels (Lankester, Patel, Cullen, Ley, & Parsonnet, 2013). The results showed that triclosan was measurable in 77% of the study population. There was a positive association between triclosan and BMI, with a 0.9kg/m^2 increase BMI in individuals who had measurable levels of triclosan in their urine (Lankester et al., 2013).

An additional study looked at this relationship in children using NHANES data from 2007-2010. Of the participants, 79% had measurable levels of triclosan in their urine (Burser, Murray, & Scinicariello, 2014). BMI z-score and waist circumference were measured while adjusting for age, race, poverty income ratio, urinary creatine and cotinine levels, caloric intake, account activity, and screen time. The results showed that obese participants had a lower urinary concentration of triclosan than overweight and normal weight participants (Burser et al., 2014). There was no association found between triclosan and BMI z-score and after age stratification, there was no association between triclosan and waist circumference (Burser et al., 2014).

Although the study mentioned previously showed no association between triclosan and BMI, a different study using 2003-2010 NHANES data showed a negative association between triclosan and BMI. Urinary triclosan concentration was measured in both adults and children with the highest concentration observed between the ages of six and mid-20's (Li et al., 2015). There was also a measurable decrease in BMI in both males and females between six and 19 years old indicating a negative association between triclosan and BMI (Li et al., 2015).

Triclosan and age, gender, socioeconomic status, race. A study using data from the 2003-2004 NHANES survey showed the relationship between demographic factors and triclosan exposure. triclosan was measured in 75% of the study population with the average level being 13µg/L (Calafat, Ye, Wong, Reidy, & Needham, 2008). Socioeconomic status, race/ethnicity, age, and sex were observed in this study. It was found that triclosan had a positive association with income. The high-income group had significantly higher levels of triclosan than the low and middle-income groups (Calafat et al., 2008). It was hypothesized that lifestyle factors and personal care product choice lead to this association. Data analysis showed that triclosan had an inverse relationship with age (Calafat et al., 2008). Triclosan concentration peaked around 30 years of age and then started to decrease. There was no observed difference in triclosan concentration between race categories or across gender (Calafat et al., 2008).

Methods

Background

Data for this study were obtained online from the National Health and Nutrition Examination Survey (NHANES) cycle 2011-2012 from the Centers for Disease Control and Prevention. The NHANES is a cross-sectional survey conducted every two years to examine the health of the American population. The survey assesses individuals' demographic information as well as dietary habits, body composition, and blood and urine measurements for environmental exposure to toxins (Centers for Disease Control and Prevention: National Center for Health Statistics, 2017).

Inclusion Criteria

Individuals were selected who were over 18 years of age and had complete information on urinary triclosan, serum thyroxine, and covariates ($N = 1,497$).

Study Measures

The participant's demographic information was obtained through an interview at the participant's home through questions asked by a trained professional (age, race, and ethnicity). Socioeconomic status was reported as annual household income in thousands. Body measurements such as height and weight (BMI calculation) were measured in a mobile examination center (Centers for Disease Control and Prevention, 2011-2012). Thyroxine levels were measured in the serum using anti-thyroxine antibody and thyroxine-alkaline phosphatase conjugate (Centers for Disease Control and Prevention, 2011-2012). Triclosan concentration was obtained in urine samples and analyzed using on-line urinary solid phase extraction (SPE) and high phase liquid chromatography (Laboratory Protocol, 2013). The study was exempt from review by the Wright State University Institutional Review Board (IRB) because the data was already collected and de-identified prior to receiving it for analysis (see Appendix A).

Statistical Analysis

Analysis was performed using Statistical Package for the Social Science (SPSS Version 24). The significance value for the hypothesis test was $p < .05$. Covariates included age, gender (male [referent category], female), socioeconomic status (<\$25,000 [referent category], \$25,000-<\$55,000, and \$55,000+), and race (non-Hispanic White [referent category], Mexican American, other Hispanic, non-Hispanic Black, and other/multi-race).

In overall, as well as gender stratified analysis, the mean and standard deviation were presented for normally distributed continuous variables and the median and interquartile range were calculated for non-normally distributed continuous variables. The count and percentage were reported for the categorical variables overall and across gender.

As triclosan was non-normally distributed it was log transformed. Categorical variables with more than two levels were dummy coded for linear regression analysis (ethnicity, socioeconomic status).

Univariate regression was performed between triclosan (independent) and thyroxine (dependent). Model building began with initial unadjusted model; in which triclosan was the exposure, and thyroxine was the outcome. The second model consisted of the initial model and the addition of age variable in an attempt to assess whether age confounds the effects of triclosan on thyroxine. This model building – adding a single variable to the initial unadjusted model with triclosan as the exposure and thyroxine as the outcome – was then repeated for each of the remaining covariates: BMI, race, socioeconomic status, and gender.

In final multivariable models, independent association between thyroxine and triclosan was assessed after adjusting for all the other covariates that is i.e. all covariates were put in the model simultaneously.

Results

Table 1 shows the characteristics of the study sample overall and by gender. Overall, there were 1,497 study participants, with 50.9% males and 49.1% females. The average age of the participants was 46.44 ± 18.41 years. When looking at the distribution of race and income, the majority of the participants were non-Hispanic White (37.6%) and in the highest income category, with 38.2% earning \$55,000+ annually. Across gender, females had a higher exposure of triclosan than males with an average level of 2.08 ng/ml compared to 1.81 ng/ml. Females also had higher thyroxine (8.29 ng/dl) levels and a higher BMI than the male participants.

Table 1

Descriptive Statistics Overall and By Gender

| Characteristics | Overall (N = 1,476) | Males 751 (50.9%) | Females 725 (49.1%) | p-value* |
|---|--------------------------------|------------------------------|--------------------------------|-----------------|
| Serum thyroxine (ng/dl), Mean \pm SD | 8.10 \pm 1.62 | 7.91 \pm 1.59 | 8.29 \pm 1.63 | .000 |
| Age, Years mean \pm SD | 46.44 \pm 18.41 | 46.40 \pm 18.47 | 46.48 \pm 18.37 | .929 |
| Race/ethnicity, n (%) | | | | .295 |
| Mexican American | 144 (9.8%) | 78 (10.4%) | 66 (9.1%) | |
| Other Hispanic | 152 (10.3%) | 66 (8.8%) | 86 (11.9%) | |
| Non-Hispanic White | 555 (37.6%) | 280 (37.3%) | 275 (37.9%) | |
| Non-Hispanic Black | 374 (25.3%) | 192 (25.6%) | 182 (25.1%) | |
| Other | 251 (17%) | 135 (18%) | 116 (16%) | |
| Socioeconomic Status, n (%) | | | | .603 |
| < \$25,000 | 479 (32.5%) | 235 (31.3%) | 244 (33.7%) | |
| \$25,000 to <\$55,000 | 433 (29.3%) | 222 (29.6%) | 211 (29.1%) | |
| \$55,000+ | 564 (38.2%) | 294 (39.1%) | 270 (37.2%) | |
| BMI, mean \pm SD | 28.73 \pm 7.05 | 28.52 \pm 6.49 | 28.93 \pm 7.60 | .353 |
| Triclosan (ng/ml), median \pm IQR | 1.97 \pm 3.20 | 1.81 \pm 2.98 | 2.08 \pm 3.46 | .444 |

Table 2 shows the unadjusted univariate analysis. Triclosan was not significantly associated with thyroxine levels ($B = -0.012$, 95% CI = $-0.055, 0.030$, $p = .565$). Additionally, triclosan was not significantly associated with any of the other covariates. These results were similar across the gender categories as well. By using the equation: $Y = \ln(1 + 10/100) \times -0.012$, a 10% difference in the natural log of triclosan was associated with a -0.001 ng/dl difference in serum thyroxine levels. When using the same equation, a 10% difference in triclosan led to a 4.78×10^{-4} ng/dl difference in thyroxine in males and a 0.004 ng/dl difference in females.

Table 2

Univariate Regression between Urinary Triclosan and Serum Thyroxine

| Characteristics | B value, (95% confidence interval), <i>p</i> -value | | |
|--|---|----------------------------------|----------------------------------|
| | Overall | Males | Females |
| Model 1: Unadjusted model with thyroxine as outcome and triclosan as exposure | -0.012, (-.055, .030), .565 | 0.005, (-0.055, 0.065), .868 | -0.038, (-0.097, 0.022), .213 |
| Model 2: Triclosan Age | -0.01, (-0.053, 0.032), .635 | 0.010, (-0.050, 0.070), .734 | -0.038, (-0.097, 0.022), .213 |
| Model 3: Triclosan Race/ethnicity | -0.014, (-0.056, 0.029), .533 | -0.012, (-0.109, 0.085), .814 | 0.038, (-0.066, 0.142), .475 |
| Model 4: Triclosan Socioeconomic status | -0.006, (-0.049, 0.036), .773 | 0.011, (-0.050, 0.072), .728 | -0.032, (-0.091, 0.028), .300 |
| Model 5: Triclosan BMI | -0.009, (-0.051, 0.033), .688 | -0.002, (-0.062, 0.059), .960 | -0.037, (-0.096, 0.023), .223 |

Table 3 shows the adjusted multivariable analysis. After adjusting for covariates, triclosan exposure did not have a significant association with serum thyroxine (B= -0.005, 95% CI= -0.047, 0.037, $p = .820$).

The analysis showed that in the final fully adjusted model, age and BMI were statistically significant predictors of thyroxine.

Table 3

Multivariable Regression between Urinary Triclosan and Serum Thyroxine

| Characteristics | B value, (95% confidence interval), <i>p</i> -value | | |
|--|---|---------------------------------|----------------------------------|
| | Overall | Males | Females |
| Model 1: Unadjusted model with thyroxine as outcome and triclosan as exposure | -0.012, (-.055, .030), .565 | 0.005, (-0.055, 0.065), .868 | -0.038, (-0.097, 0.022), .213 |
| Model 2: Triclosan | -0.01, (-0.053, 0.032), .635 | 0.010, (-0.050, 0.070), .734 | -0.038, (-0.097, 0.022), .213 |
| Age | 0.007, (0.003, 0.012), .001 | 0.009, (0.002, 0.015), .006 | 0.006, (0.000, 0.013), .060 |
| Model 3: Triclosan | -0.012, (-0.054, 0.031), .590 | 0.003, (-0.057, 0.064), .910 | -0.037, (-0.096, 0.022), .220 |
| Age | 0.008, (0.003, 0.012), .001 | 0.010, (0.004, 0.016), .002 | 0.006, (0.000, 0.013), .058 |
| Race/ethnicity | | | |
| Non-Hispanic White | -0.184, (-0.376, 0.009), .061 | -0.039, (-0.655, -0.125), .004 | 0.025, (-0.251, 0.300), .861 |
| Non-Hispanic Black | 0.046, (-0.167, 0.259), .671 | -0.217, (-0.509, 0.075), .145 | 0.324, (0.017, 0.631), .038 |
| Model 4: Triclosan | -0.006, (-0.049, 0.036), .767 | 0.008, (-0.053, 0.068), .800 | -0.032, (-0.092, 0.028), .293 |
| Age | 0.007, (0.003, 0.012), .001 | 0.009, (0.003, 0.016), .003 | 0.006, (-0.001, 0.012), .078 |
| Race/ethnicity | | | |
| Non-Hispanic White | -0.184, (-0.376, 0.008), .061 | -0.386, (-0.651, -0.121), .004 | 0.017, (-0.258, 0.293), .903 |
| Non-Hispanic Black | 0.030, (-0.184, 0.243), .785 | -0.232, (-0.525, 0.061), .121 | 0.306, (-0.001, 0.613), .051 |
| Socioeconomic status | | | |
| Low Income | 0.243, (0.044, 0.442), .017 | 0.189, (-0.086, 0.464), .179 | 0.260, (-0.024, 0.545), .073 |
| Middle Income | 0.049, (-0.155, 0.252), .639 | 0.003, (-0.247, 0.281), .981 | 0.068, (-0.227, 0.362), .653 |
| Model 5: Triclosan | -0.005, (-0.047, 0.037), .820 | 0.008, (-0.052, 0.068), .804 | -0.028, (-0.088, 0.031), .346 |
| Age | 0.007, (0.002, 0.011), .002 | 0.009, (0.003, 0.051), .003 | 0.005, (-0.002, 0.011), .144 |
| Race/ethnicity | | | |
| Non-Hispanic White | -0.220, (-0.411, -0.029), .024 | -0.405, (-0.714, -0.185), .001 | 0.007, (-0.266, 0.281), .958 |
| Non-Hispanic Black | -0.088, (-0.304, 0.128), .424 | -0.334, (-0.629, -0.039), .026 | 0.179, (-0.134, 0.492), .261 |
| Socioeconomic status | | | |
| Low Income | 0.208, (0.011, 0.406), .039 | 0.187, (-0.085, 0.460), .177 | 0.198, (-0.087, 0.482), .173 |
| Middle Income | 0.035, (-0.167, 0.236), .373 | 0.024, (-0.251, 0.298), .866 | 0.027, (-0.267, 0.320), .858 |
| BMI | 0.032, (0.020, 0.144), .000 | 0.035, (0.017, 0.053), .000 | 0.029, (-0.013, 0.045), .001 |

Discussion

In this study, urinary triclosan did not have a significant effect on serum thyroxine levels in individuals aged 18 and over among U.S. general population, overall and when stratified by gender. The results showed that females had higher levels of thyroxine than males. Although females had higher levels of serum thyroxine than males (8.29 ng/dl), those levels were in the normal acceptable range (average levels of serum thyroxine for adults is between 4.6 µg/dl and 12 µg/dl) (Wilson et al., 1998). One of the possible reasons for the higher serum thyroxine levels in females could be because of the higher mean serum concentration of estrogen in women. Estrogen increases the concentration of thyroxine binding globulins in the blood which elevates the concentration of bound thyroxine (Utiger, 2001).

These results are consistent with previous findings. One study investigated the relationship of parabens and thyroid hormones using 2007-2008 National Health and Nutrition Examination Survey data. The results were stratified by gender and found a negative association between triclosan and thyroxine in both males and females (Koeppe, Ferguson, Colacino, & Meeker, 2013). Although there was a negative association, triclosan was not a statistically significant predictor of serum thyroxine (Koeppe et al., 2013).

Since this was a cross-sectional study, a causal relationship between triclosan and thyroxine could not be established. For causal association, there needs to be a strong relationship between the exposure and outcome, which was not present in this study. Also, with this being a cross-sectional study, temporality (exposure precedes the outcome) could not be determined. An additional criterion to determine causality is consistency across studies. Prior studies have reported inconsistent findings association between triclosan and thyroxine, while no relationship was observed in the current study.

The strength of this study was the use of national level data, which allows us to generalize results to the entire U.S. adult population. Also, the most recent data that included both triclosan and thyroxine levels were used. We explored the association in both men and women. Currently there is a lack of epidemiological studies that explore that the relationship of triclosan and thyroxine across both genders.

Weaknesses to this study include the potential for additional confounding factors that were not adjusted for. A previous study that observed the relationship between triclosan and thyroxine adjusted for multiple factors that were not included in the current analysis. They adjusted for education level, urinary creatinine levels, smoking status and alcohol intake (Koeppel et al., 2013). Not adjusting for urinary creatinine levels is a weakness of this study. Urinary creatinine levels are indicative of kidney function (Davis, 2017). Elevated urinary creatinine levels can indicate poor filtration and kidney disease (Davis, 2017). If study participants had elevated urinary creatinine levels, that could confound the results of the study.

Endocrine disrupters are a public health issue and impact the burden of chronic disease. The endocrine system, and particularly the thyroid, plays an essential role in regulating bodily functions. Thyroid hormones regulate metabolism, temperature, and weight. Endocrine disrupting chemicals such as triclosan can have an impact on these bodily functions. There needs to be an increase in public awareness about the use of antibacterial chemicals such as triclosan in daily use consumer products. Consumers need to be aware of which products to avoid and how to protect them from endocrine disrupting compounds.

Conclusion

Current epidemiological research is lacking in exploring an association between daily use consumer products containing triclosan and the metabolic impacts of such products, particularly

on thyroxine. Additional research should be done with a larger sample size to further assess the relationship between triclosan and thyroxine.

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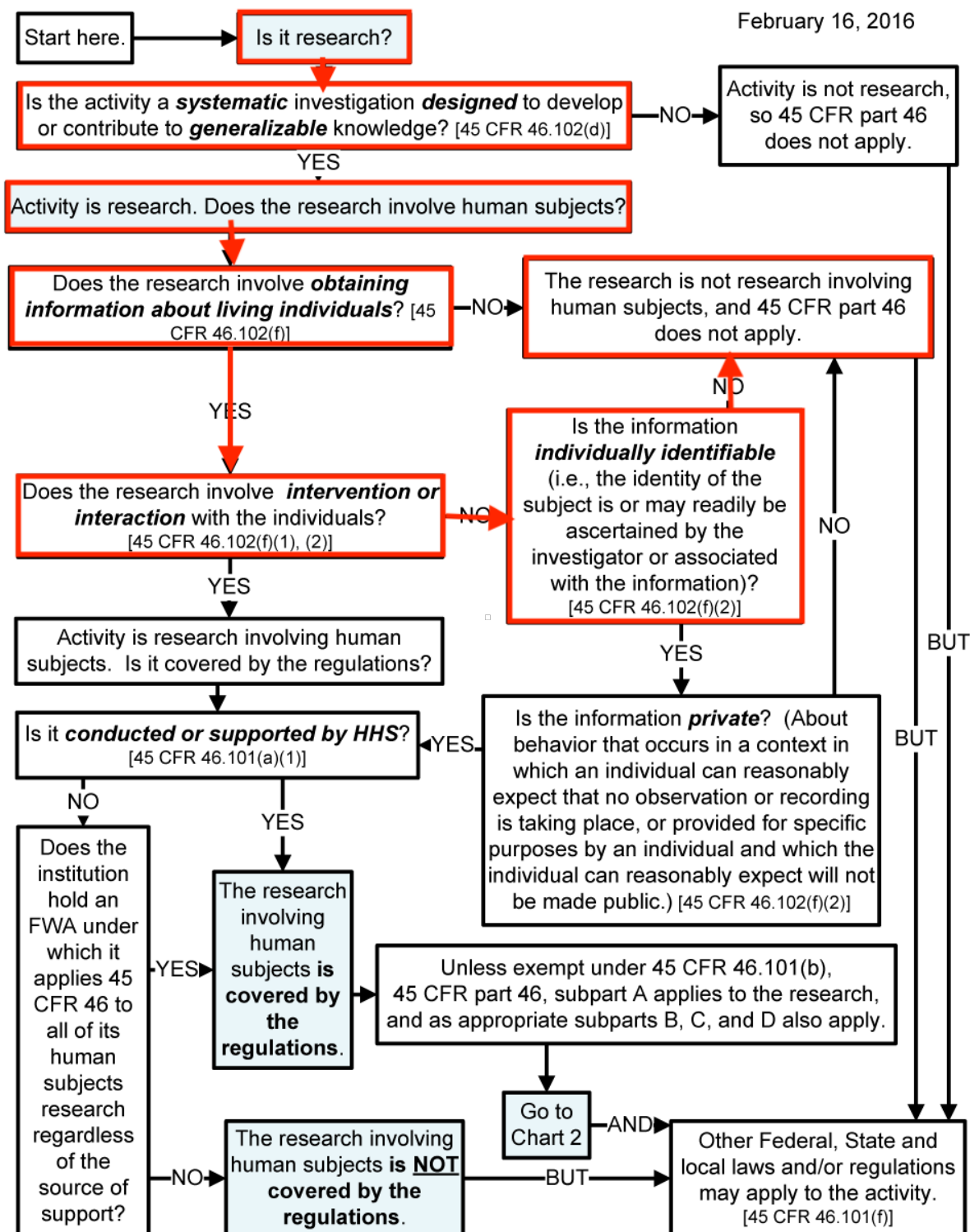
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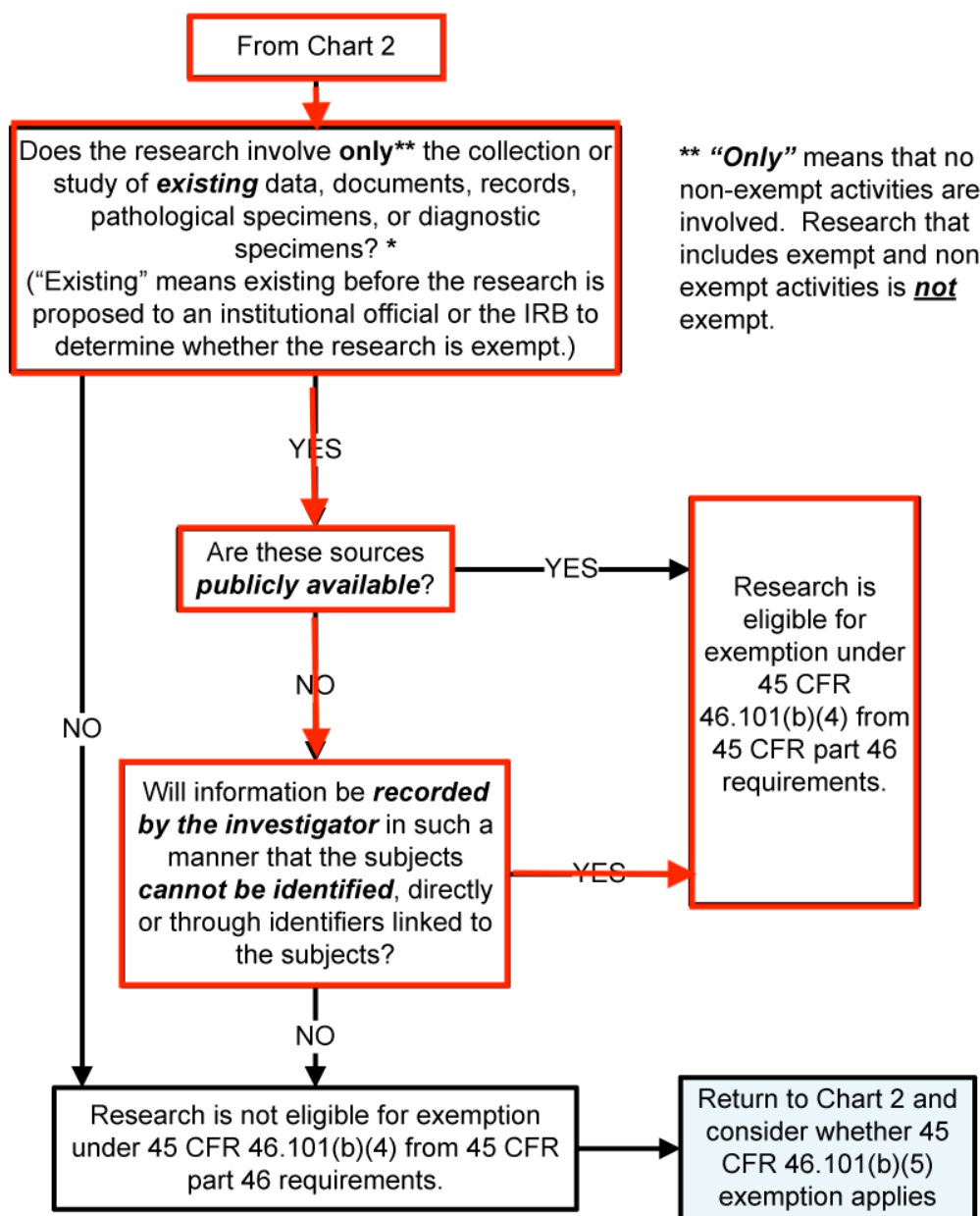
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Charts taken from <https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts/index.html>





* Note: See OHRP guidance on research use of stored data or tissues and on stem cells at <http://www.hhs.gov/ohrp/regulations-and-policy/guidance/guidance-on-research-involving-stem-cells/index.html>, and on coded data or specimens at <http://www.hhs.gov/ohrp/regulations-and-policy/guidance/research-involving-coded-private-information/index.html> for further information on those topics.

February 16, 2016

Appendix B: List of Competencies Met in Integrative Learning Experience

Wright State Program Public Health Competencies Checklist

| |
|--|
| Assess and utilize quantitative and qualitative data. |
| Apply analytical reasoning and methods in data analysis to describe the health of a community. |

Concentration Specific Competencies Checklist

| Population Health Concentration |
|--|
| Demonstrate application of an advanced qualitative or quantitative research methodology. |